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Are Mental Processes in Space? W. P. MONTAGUE.

The speaker protested first against the current paradoxical view of mental processes as real occurrences that occur nowhere. They should be located in space for the following reasons: (1) They are naturally felt to be within the body; (2) they form no exception to the generally accepted rule that an invisible event, such as an electric current, is to be located in the visible object that directly conditions it; (3) their phenomenal existence in space (like their existence in time) is not in conflict with the transcendental view that space and time are appearances; (4) that they are neither punctiform nor figured is no argument against their location in space, for many things—notably, sounds and odors—are definitely located in space without being regarded as either punctiform or figured; (5) the objection that there is no room in space for anything but matter and motion, and that thoughts and feelings if they were really in the brain would have to be regarded as visible substances between or alongside of the brain molecules, is invalid, for it disregards the fact that sensations are intensive and not extensive, and that they must, therefore, occupy space in the same way as other intensities, such as stresses, velocities and accelerations, which exist in space *along with* their matter and not *alongside* of it.

The last part of the paper explained and defended the hypothesis that mental states are the modes of potential energy (expressible in terms of the higher derivatives of space with regard to time) into which the kinetic energy of the nerve currents must be transformed in order to be redirected. The theory, if true, would justify the belief in interaction without violating the parallelists' contention that the spatial can only be causally related to what is in space.

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REVIEWS AND ABSTRACTS OF LITERATURE

Das Farbenempfindungssystem der Hellenen. W. SCHULTZ. Leipzig: J. A. Barth. 1904. Pp. 227; 3 colored tables.

This book returns to the old subject, discussed several decades ago by Gladstone, Geiger, Magnus and their opponents, of the color sense of the Greeks as revealed in their use of color names. The author, primarily a philologist, has informed himself regarding the psychology of color, and stands in this respect on a distinctly higher level than his predecessors. His studies lead him also to quite a different conclusion from the famous one of Geiger and Magnus, for whereas the older authors hold that the Greeks, at the dawn of their history, sensed red and yellow only, and only slowly developed a sense for green and blue, Schultz rejects the notion of such a development, since he finds the same looseness of color naming to obtain from the earliest writers to the latest. He reaches, however, the scarcely less startling conclusion that the Greeks were as a race color-blind, and yellow-blue blind at that.

The author seeks first of all to establish general criteria for inferring sensory defects from looseness of nomenclature. Where a color name is primarily the name of an object which itself presents different colors—such as the apple—an apparent confusion in the use of the name is no proof of true sensory confusion. Moreover, it is necessary to distinguish between the range of application of the name (its 'Spielbereich'), and a genuine manifoldness of usage ('Vieldeutigkeit'). To include under one name colors that shade into each other, such as green and blue, is no proof of sensory confusion; but to include discontinuous colors is proof. [Even this refined criterion is not above criticism, since, as Myers[1] has shown for present-day Scots, as well as for various primitive peoples, and Chamberlain[2] for North American Indians, the same word may be applied to discontinuous tastes, sour and bitter, or salt and bitter, though it is very unlikely that these races lack any of the four primary taste sensations. A continuity may indeed be felt between sour and bitter, or between salt and bitter, but it is of an emotional rather than of a purely sensory character. It is a mistake to suppose that people who have not made a psychological analysis of sensations should use sense names to denote *purely sensory* qualities, or that the continuity which they feel between their different applications of the same name should necessarily be a purely sensory continuity.]

The author proceeds (pp. 16–82) to examine the usage of 51 color names. In distinction from his predecessors, he lays comparatively little stress on citations from the poets, believing that prose writers, and especially scientific writers, furnish the more exact and literal sense. He makes use especially of Aristotle and his commentators, of Plato, Theophrastus, Democritus, Galen and the lexicographers. Of the 51 color names, 19 showed two or more discontinuous meanings, and of these 8 are strictly abstract names, not naming the color by reference to any object; they include the common names for red, yellow, green, blue and violet. From these linguistic facts, the author believes it possible (p. 94) to infer that the Greek color sense was deficient in comparison with what we know as the normal. Incidentally he asserts that no similar conclusion can be drawn from the Latin.

Although the linguistic material shows the color sense of the Greeks to have been abnormal, it does not, alone, permit an exact diagnosis of the abnormality. The author, therefore, turns to other sources of information. The descriptions of the rainbow by Xenophanes, Anaximenes, Aristotle, Metrodorus and Posidonius are utilized; most of these do not give a detailed description, but Aristotle and Posidonius seem to aim at completeness. Aristotle's description is correct, but that of Posidonius appears to err in the order of the colors, by interchanging green and violet. Aristotle's account of after-images is also considered, and his curious statement is pointed out that the after-image has the same color as the original light, for which Aristotle gives the examples of white and green lights. Next, the author turns to the detailed accounts of simple and mixed colors given by Plato and Democritus. It is argued that Democritus would be likely to base his statements on experiment, but when the Democritean components for a given color are mixed, the result is often quite different from that color. It would appear that Democritus was color-blind; and the same would apply to Plato but for the doubt whether Plato would experiment. A colored table shows the striking discrepancies between the Democritean results of color mixture and the normal results.

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[1] 'The Taste-Names of Primitive Peoples,' *British Journal of Psychology*, Vol. I., p. 117.

[2] 'Primitive Taste Words,' *American Journal of Psychology*, Vol. XIV., p. 410.

A start is also made towards an archeological study of the Greek color sense as revealed in their paintings. Only one example was available, and that in a lithographed reproduction, of which a copy is inserted—a fresco unearthed at Eleusis, representing Zeus wearing a violet robe, on which, however, there are green streaks, and resting his feet on a wooden stool, the top of which is, however, green. The author concludes (p. 149) that the painter, and also those who accepted the painting and who enjoyed it, were unable to distinguish green from violet and from wood-color. As regards all but the painter himself, however, it should be noted (p. 192) that our author showed the picture to about 100 persons, only one of whom spontaneously noticed anything wrong in the coloring.

After a chapter devoted to the description of different types of color-blindness, the author proceeds to a diagnosis of the Greek color-sense. He decides that the most striking confusion is between greens and violets, as seen in the painting of Zeus, in Posidonius's description of the rainbow, in one of Democritus's false mixtures, and in the interchangeable use of words for green and violet. As these are confusion colors in blue-yellow blindness, he diagnoses the Greek anomaly in that way; and finds his diagnosis confirmed by the lack of definite, unequivocal terms for yellow and blue in the language (for κυανοῦν he decides to have meant a luminous black, with which blue was confounded; ξανθόν meant orange rather than yellow, while ὠχρόν covered the whole range from red through yellow to green). In an appendix, he seeks to meet objections raised on the score of probability by pointing out that every people is in part color-blind, *i. e.*, contains color-blind individuals and strains; the Greeks may have had so large a proportion of the color-blind as to determine the language of color.

If, however, the author's argumentation is critically examined, it falls of its own weight. It proves too much. Rather arbitrarily, in making his diagnosis, he has emphasized one class of confusions (green-violet), to the neglect of others which he had established fully as well. This will be seen from the list of color names on which he bases his linguistic proof of abnormality, with their proper and anomalous uses:

ἐρυθρόν, properly *red;* also *green.*
ξανθόν, properly *orange, yellow,* or *brown;* also *green.*
ὠχρόν, *red, orange, yellow, green.*

χλωρόν, properly *yellowish green;* also *green, brown.*
χαροπόν, properly *light blue, green;* also *red.*
κυανοῦν, *blue* and *black.*
ἁλουργές, properly *violet;* also *green.*
γλαυκόν, *red, orange, green, blue.*

From this list it will be seen that green is not confused with violet only, but often with red, and also with orange, yellow and blue,—in fact, with every color of the spectrum. Red is confused with orange, yellow, green and blue; yellow with red, orange, green and blue; and blue with red, orange, green and black. All in all, it would seem that no two colors were clearly distinguished, and the proper diagnosis would be *total* color-blindness. About the same thing can be said of the color mixtures of Democritus: some are correct, some show yellow-blue blindness, but others red-green blindness. Probably the correct diagnosis in his case is that he was not experimenting after all, but speculating, as Aristotle was when he derived all the colors from a mixture of black and white. Aristotle's after-image statement would seem to show that the negative after-image of any color—since white and green are simply examples—appeared to him like the original; therefore he was unable to distinguish any color from its complementary, and was totally color-blind. Even the painter of the Eleusinian Zeus confused green not only with violet (yellow-blue blindness), but also with the brown of wood (red-green blindness). For a people who developed a large color vocabulary, and used it in the main with little evident confusion, the diagnosis of total color-blindness would be a *reductio ad absurdum* of the argument; yet that was what the author's evidence led him to, if taken in all seriousness, rather than to his comparatively weak-kneed diagnosis of yellow-blue blindness.

Evidence which, taken at its face value, leads to an absurd conclusion must be worth less than at first appears. In fact, a rereading of the author's work shows a possible escape from nearly every piece of evidence presented. If Democritus did not base his statements on experiment; if Posidonius, in asserting the rainbow to contain 'first, red; second, purple and violet; third, blue and green,' was thinking of some other than the spatial order of the colors; if the *lining* of Zeus's robe, in the Eleusinian painting, was intended to be green—then nearly all but the linguistic evidence would disappear. The confusions in color names are scarcely better established. Thus ἐρυθρόν is used so consistently to mean red as to leave our author no doubt of its proper application; but he finds Theophrastus, in speaking of a group of red flowers, describing one as ἐγχλωρότερον, 'more tinged with green,' than another; still, a red corolla may have green streaks on it. ξανθόν had apparently a wide range of application, running from red to greenish yellow; the author asserts, however, without of course being able to present his evidence for this universal negative, that it never meant pure yellow; so that as orange and as yellowish green it would have discontinuous applications. Practically the same applies to ὠχρόν; it should be said that the equation ξανθόν = ὠχρόν = χλωρόν seems to be founded only on the late lexicographer Hesychius. χλωρόν clearly meant a yellowish green; difficulty arises from its occasional application to such things as blood, roses and the nightingale, but the other meaning 'fresh' may perhaps explain these cases. For *χαροπόν* the different meanings are only very indirectly established. *ἁλουργές* usually meant violet, and the meaning green is only got from Posidonius's description of the rainbow, discussed above. Our old friend *γλαυκόν* is shamefully treated; first it is denied its traditional meaning of bright or light (as in *γλαυκῶπις Ἀθήνη*), and compelled to do duty as a color name; then it is caught referring to objects of several different colors, and so overwhelmed with confusion. On the whole, there are very few of the instances quoted for which a plausible explanation does not readily occur to mind. And there is one general consideration that should be borne in mind: here and there an author may indeed have been color-blind. Out of 70 authors cited, probably some two or three were red-green blind, provided this defect were as prevalent among the Greeks as among modern Europeans. But as for showing that the Greeks as a race were defective in the color sense, the evidence adduced amounts to practically nothing. The close relation between *κυανοῦν* (blue) and black is, indeed, curious, but it is of common occurrence in the speech of other peoples, who, on being tested, are found not to be yellow-blue blind, nor specially defective in the perception of blue.

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Ueber die Erzeugung physikalischer Kombinationstöne mittels des Stentortelephons. KARL L. SCHAEFER. *Annalen der Physik,* Bd. 17, 1905. Pp. 572–583.

This paper is of interest to psychologists by reason of certain technical suggestions. Schaefer finds that various pairs of tuning-forks sounding in front of a Stentormikrophon are reproduced with great distinctness in a telephone that may be in a distant room, and that the first and sometimes the second difference-tone are actually emitted from the transmitter, and so strongly as to excite resonators or even tuning-forks of the corresponding vibration rates. An objective summation-tone coming from the telephone was also in several cases demonstrated. It seems certain that these difference- and summation-tones are produced by the telephone diaphragm and not by the microphone, and Schaefer suggests that, in spite of numerous adverse criticisms, Helmholtz may have been right in supposing that 'subjective' difference-tones and combination-tones originate in the ear-drum, which is in many respects similar to the diaphragm of a telephone.

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Eine virtuelle stereoskopische Täuschung. PAUL CZERMAK. *Zeitschrift für den physikalischen und chemischen Unterricht,* XVII., Jahrgang. S. 341.

After briefly reviewing the optical illusions described by Roget, Plateau, Faraday and Emsmann, the author described a new illusion that